Vicarious Calibration for JAXA MSI L2 cloud product (MSI_CLP) of EarthCARE

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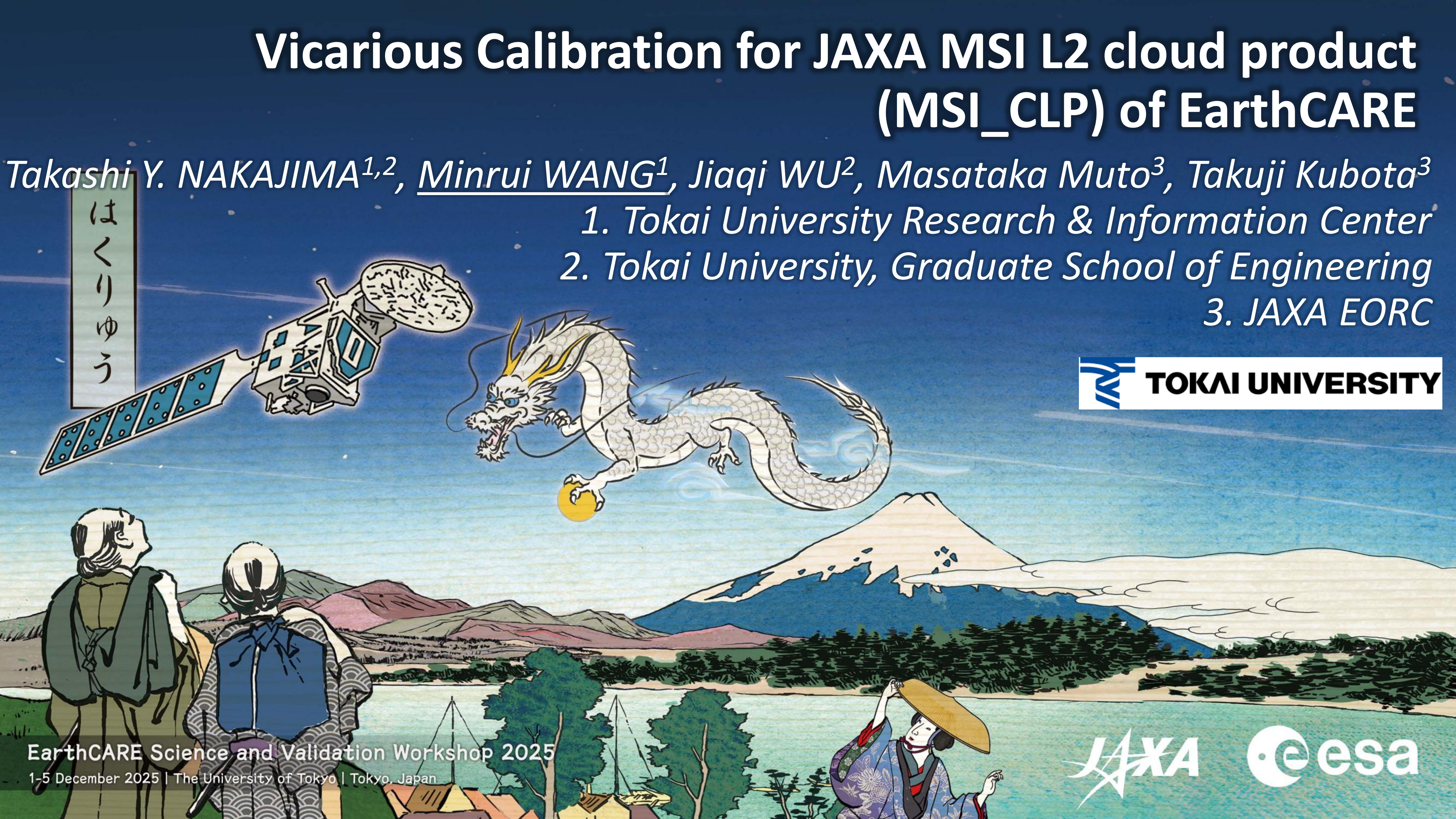


JAXA esa

Image of the vicarious calibration for MSI_CLP

②Calculate MSI observed radiance ($L_{MSI,CAL}$) from (τ_c, R_e), which do not depend on satellites.

$$L_{MSI,CAL}=F(\tau_c, R_e)$$

F infers the LUT of CAPCOM

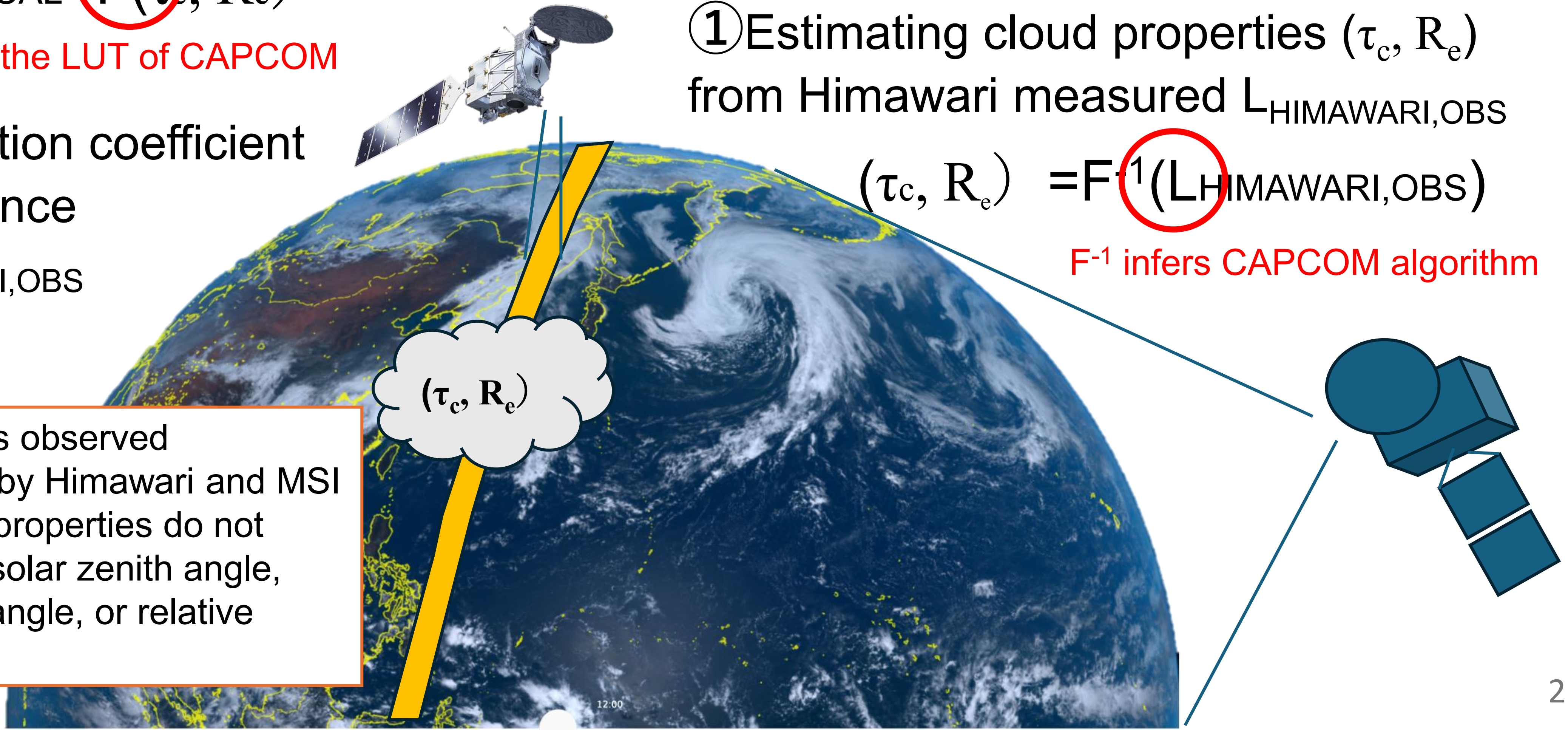
①Estimating cloud properties (τ_c, R_e) from Himawari measured $L_{HIMAWARI,OBS}$

$$(\tau_c, R_e) = F^{-1}(L_{HIMAWARI,OBS})$$

F^{-1} infers CAPCOM algorithm

③The calibration coefficient k of MSI radiance

$$k=L_{MSI,CAL}/L_{MSI,OBS}$$



- Targeting clouds observed simultaneously by Himawari and MSI
- Cloud physical properties do not depend on the solar zenith angle, satellite zenith angle, or relative azimuth angle.

Principles of MSI observation radiance vicarious calibration

- CAPCOM's LUT is grid data that uses cloud top altitude as altitude information. ($F(\tau_c, R_e)$)
- Normally, τ_c and R_e are retrieved from the inverse function F^{-1} of the LUT from the observed radiance as input from L1C data. However, in this case, τ_c and R_e retrieved from Himawari are used as input, and the corresponding radiance ($L_{MSI, CAL}$) is estimated by radiative transfer calculation.

"Remote sensing" is a process for developing retrieval algorithms.

- We have measured I_λ by satellite remote sensing.

$$I_\lambda = F\{\omega_a, \omega_c, \tau_a, r_c, \tau_c, \tau_{molecule}, T(Z), \ldots\}$$

- How to retrieve "r_c and τ_c" from I_λ?

$$(r_c, \tau_c) = F^{-1}\{I_\lambda, \omega_a, \omega_c, \tau_a, \tau_{molecule}, T(Z), \ldots\}$$

T.Y. Nakajima, CAPCOM Operation Handbookより

Himawari cloud retrieval

Date： Sep. 22, 2024 （autumnal equinox day）

1. JRA-3Q long-term reanalysis data provided by the Japan Meteorological Agency

https://search.diasjp.net/ja/dataset/JRA3Q

2. Albedo： rmin_modis.201710.ch1.dat

3. Himawari gridded data.

http://www.cr.chiba-u.jp/databases/GEO/H8_9/FD/index_jp.html

リモート サイト: /gridded/FD/V20190123/202409/EXT

名前	サイズ	種類
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202409220150.ext.fld.loff.txt.bz2	65,285	bz2-ファ...
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202409220210.ext.01.fld.geoss.bz2	397,524,097	bz2-ファ...
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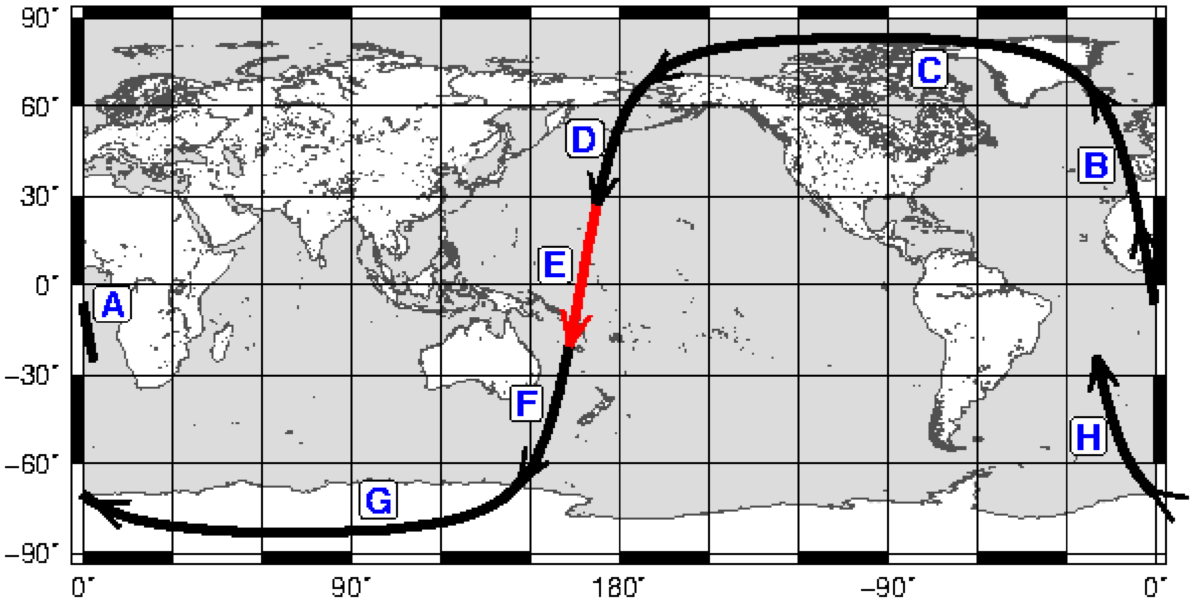
12738 個のファイル. 合計サイズ: 1,154,569,458,710 バイト

MSI_CLP Cloud Products Used

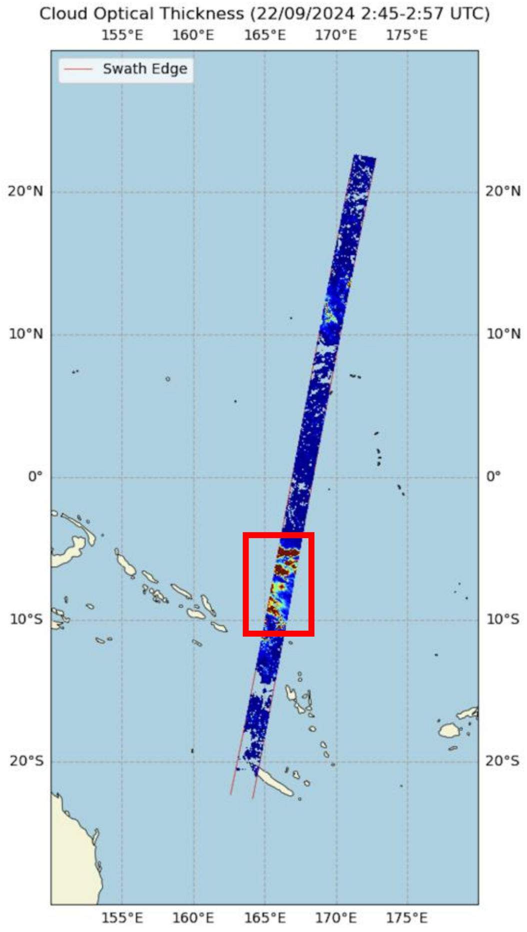
- Sep. 22, 2024 (autumnal equinox day)
- Frame number, time (UTC):
- 01807E 02:45~02:57
- 01808D 04:06~04:18
- 01808E 04:18~04:30

- L1C data version:
- vBa

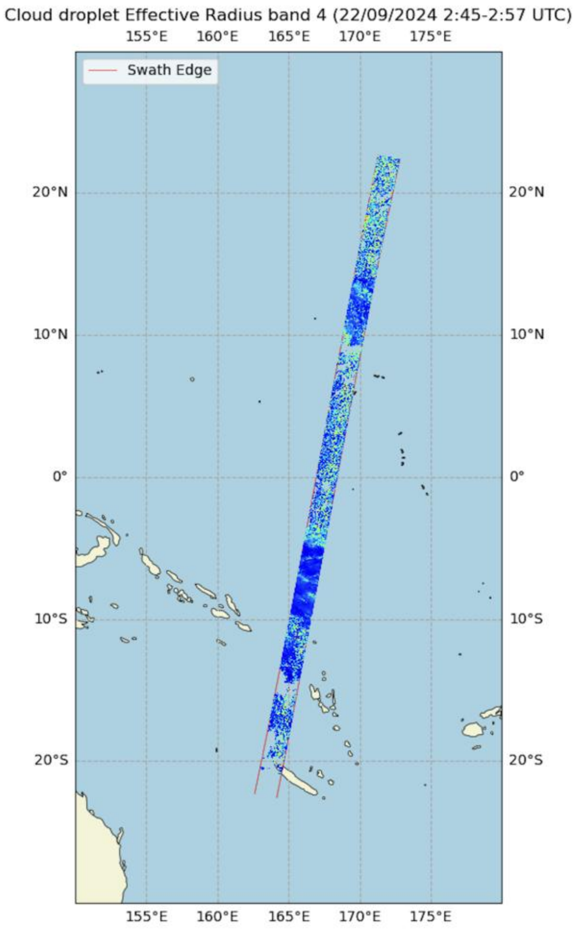


MSI_CLP vs Himawari-9 AHI example: 01807E (UTC 02:45~02:57)

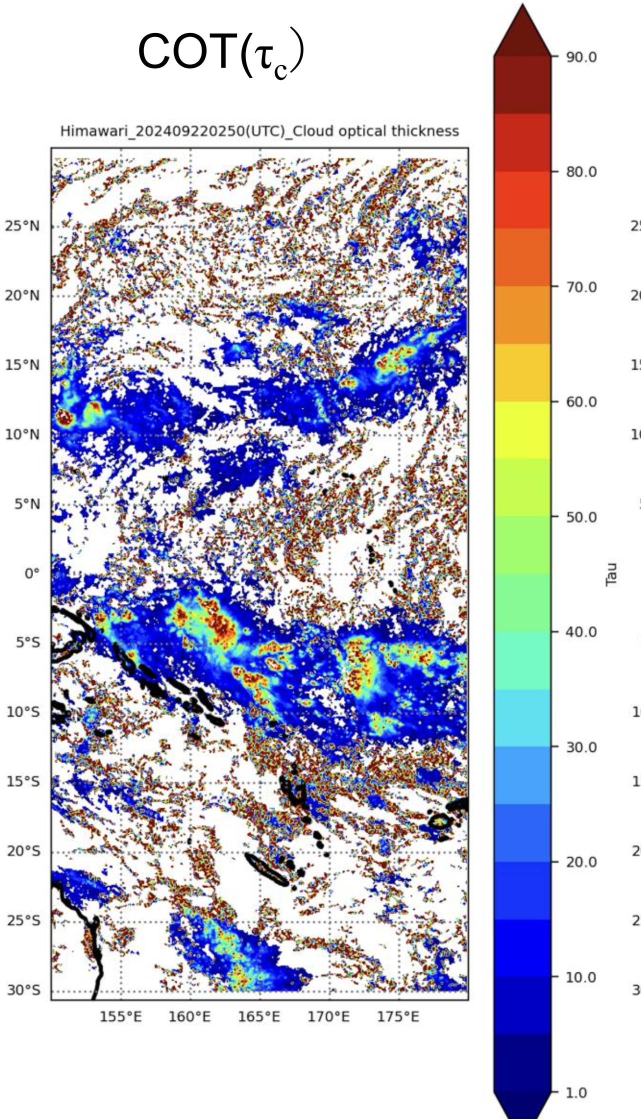
COT(τ_c)



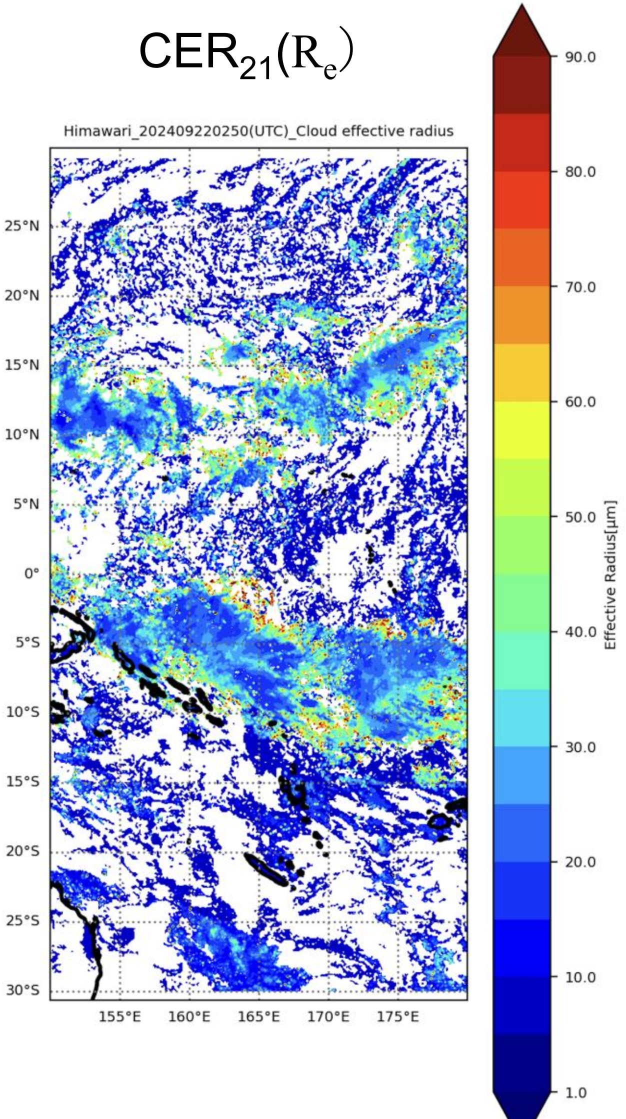
CER$_{21}$(R_e)



COT(τ_c)



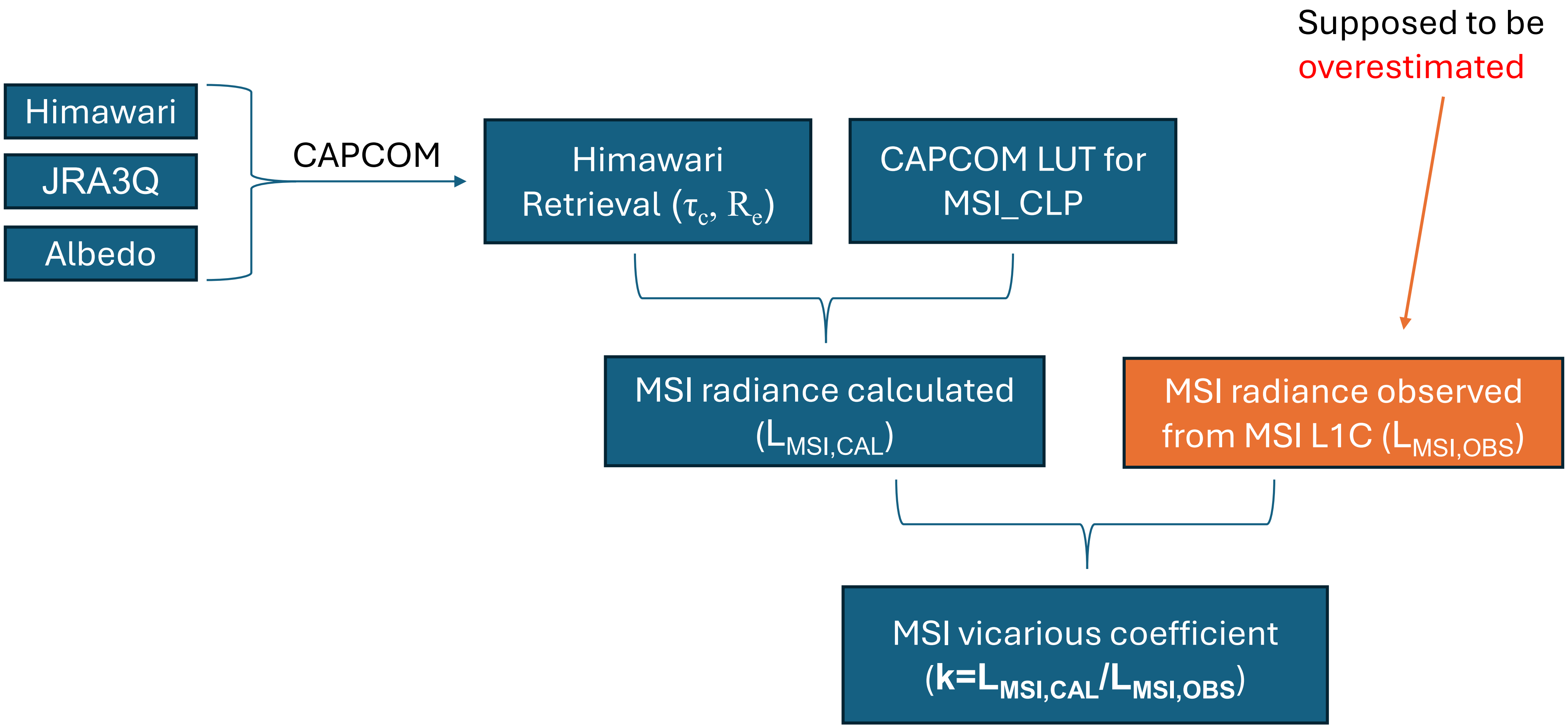
CER$_{21}$(R_e)



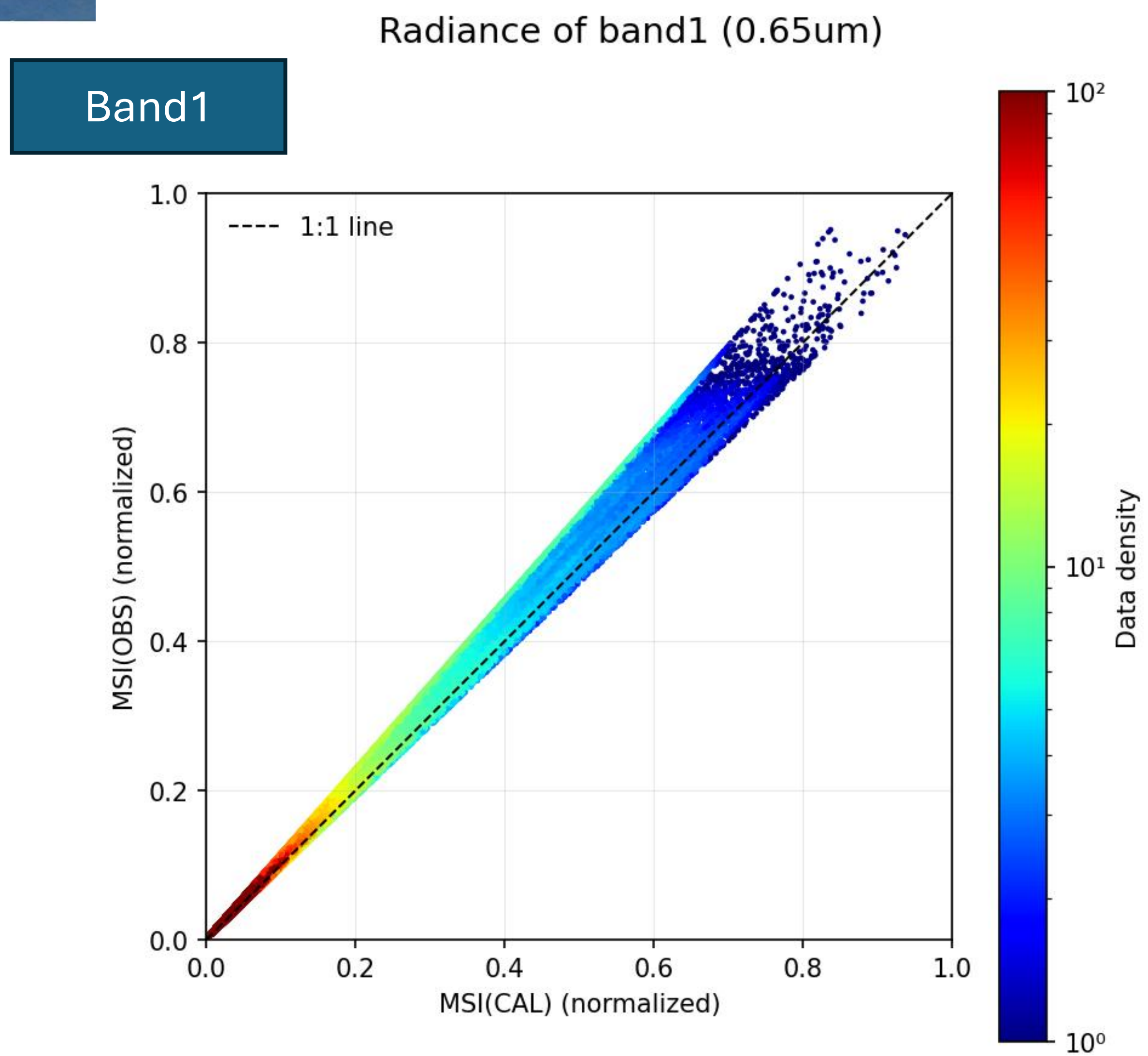
Data Screening

- Water cloud pixels are screened based on the condition that the cloud top temperature $T_c > 260K$.
- From the screened Himawari data, pixels that match the MSI frames are extracted, and COT (τ_c) and CER (r_e) are used as input data for radiative transfer.

Flowchart of MSI observation radiance vicarious calibration

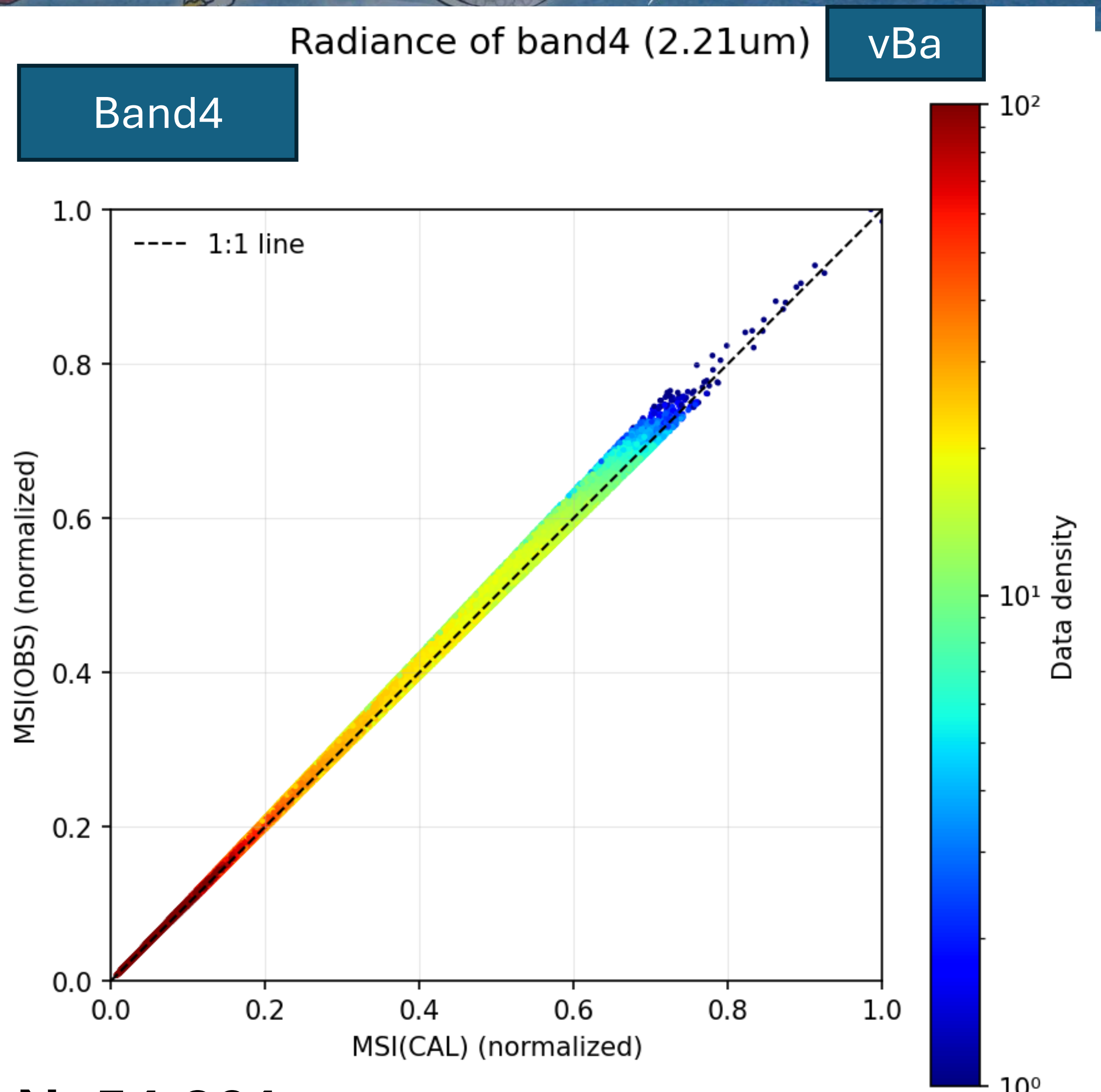


01807E UTC 02:45~02:57



N=54,861

k=$L_{MSI,CAL}/L_{MSI,OBS}$=0.93



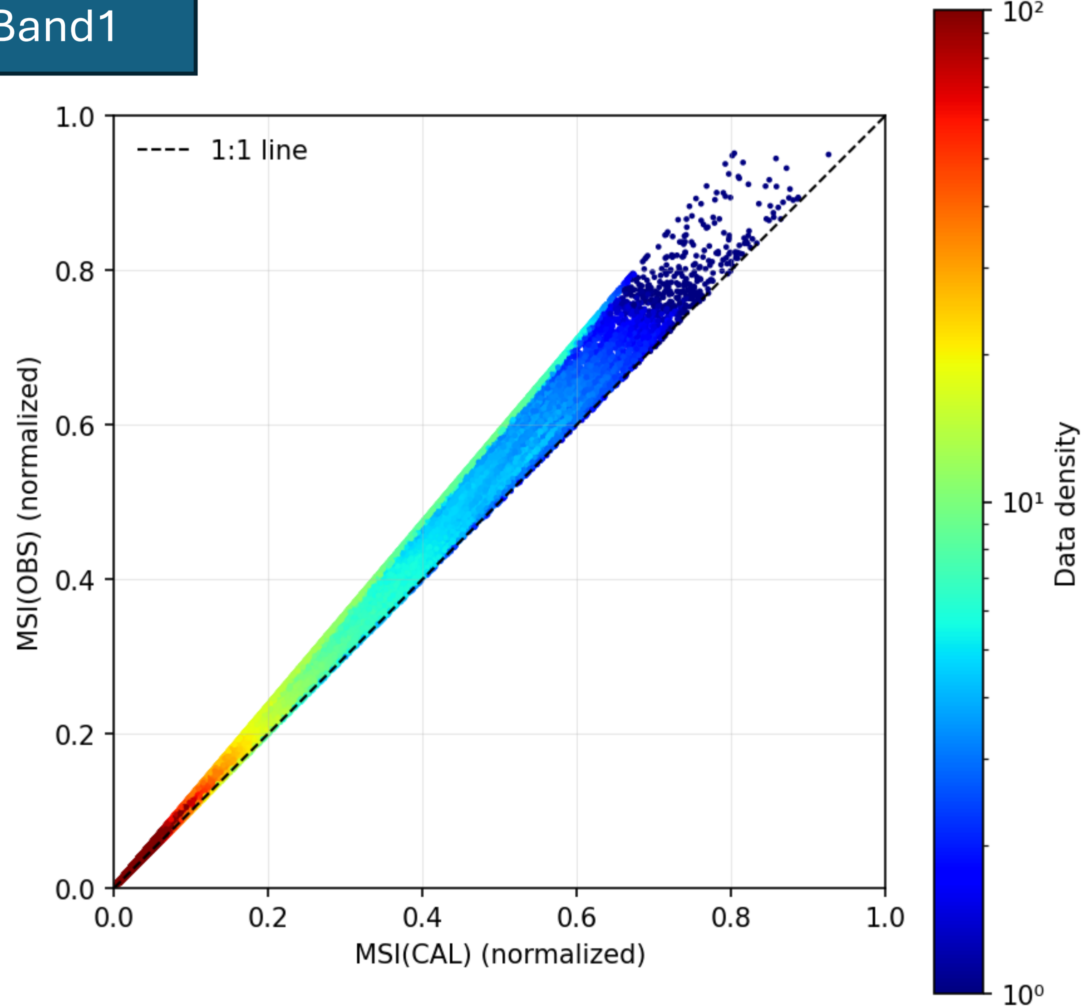
N=54,861

k=$L_{MSI,CAL}/L_{MSI,OBS}$=0.99

01808D UTC 04:06~04:18

Radiance of band1 (0.65um)

Band1



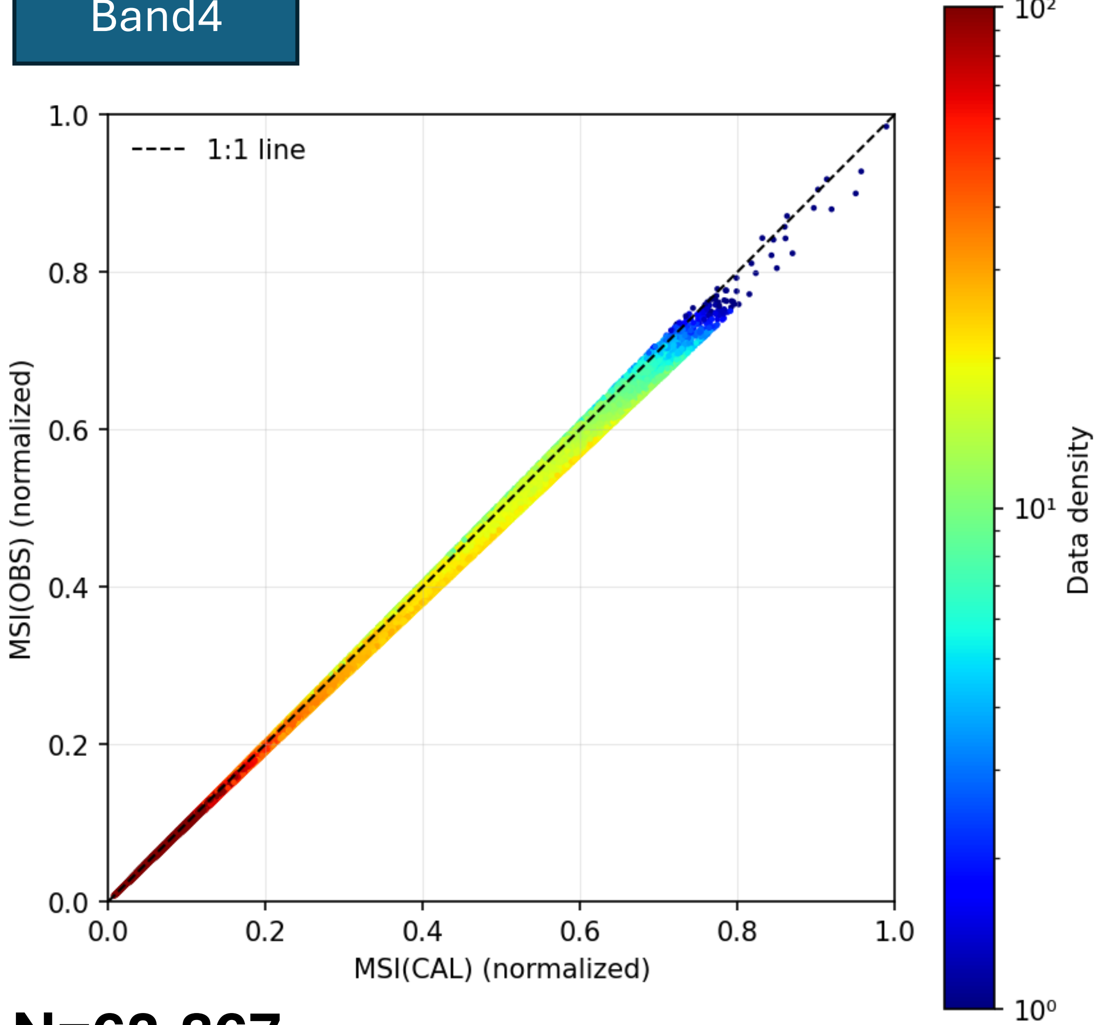
N=62,367

$k=L_{MSI,CAL}/L_{MSI,OBS}$=0.92

Radiance of band4 (2.21um)

vBa

Band4



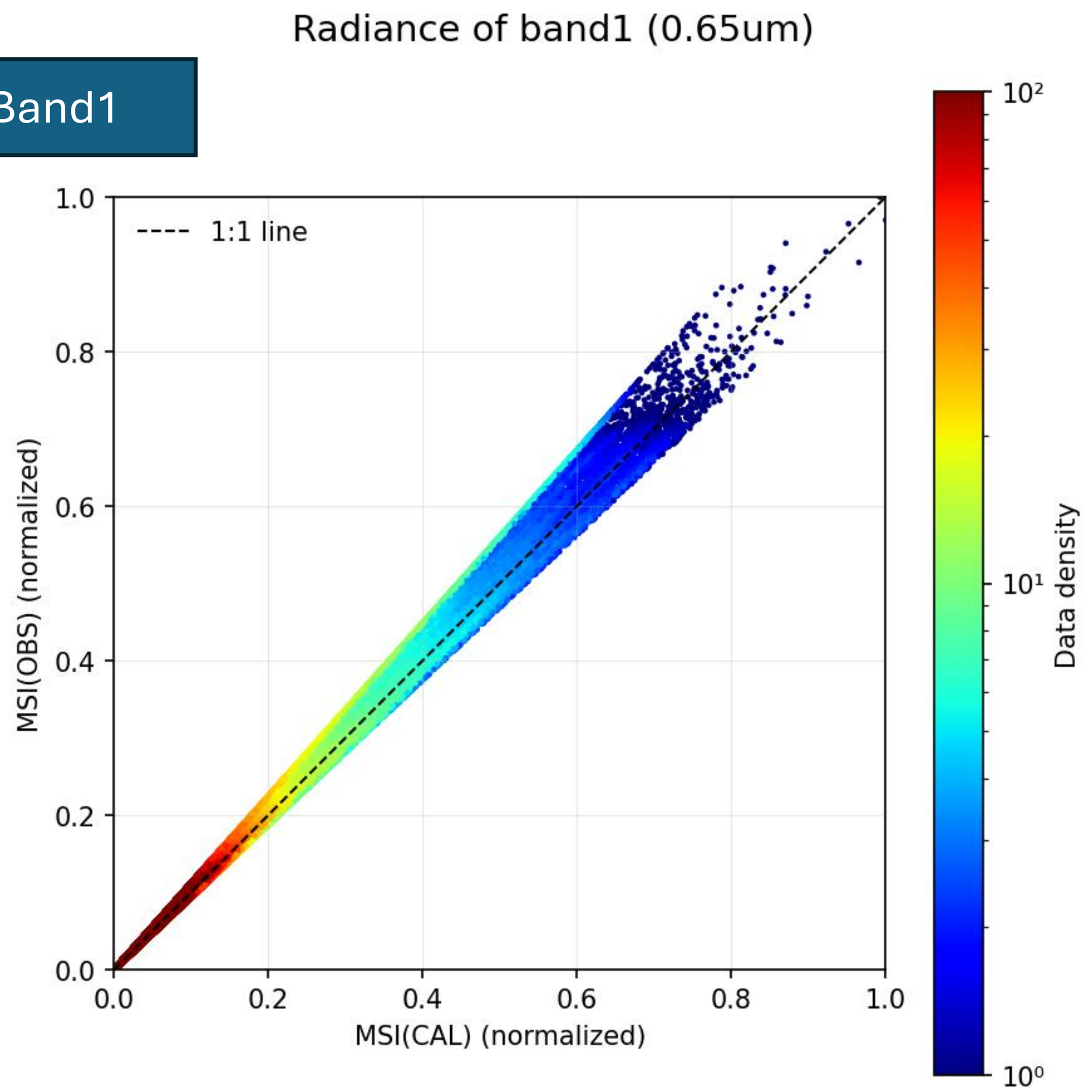
N=62,367

$k=L_{MSI,CAL}/L_{MSI,OBS}$=1.04

01808E UTC 04:18~04:30

vBa

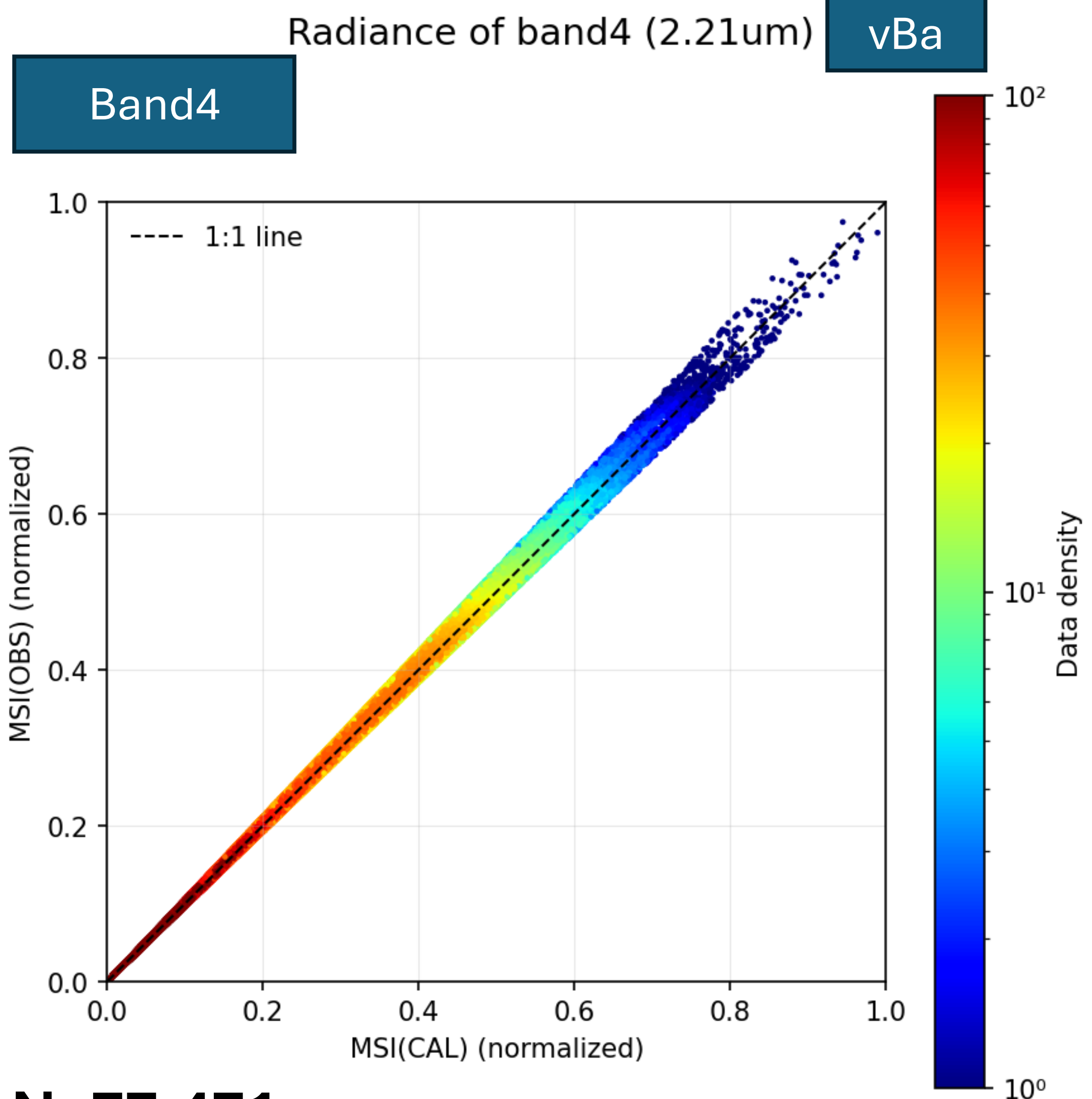
Band1



N=77,471

$k=L_{MSI,CAL}/L_{MSI,OBS}$=0.94

Band4



N=77,471

$k=L_{MSI,CAL}/L_{MSI,OBS}$=1.02

Application of the calibration coefficient

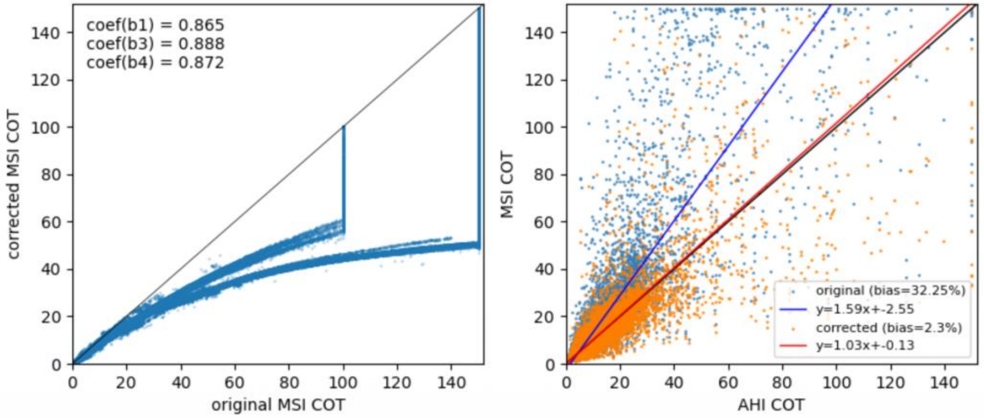
(Quoted from Mr. Muto's recent work)

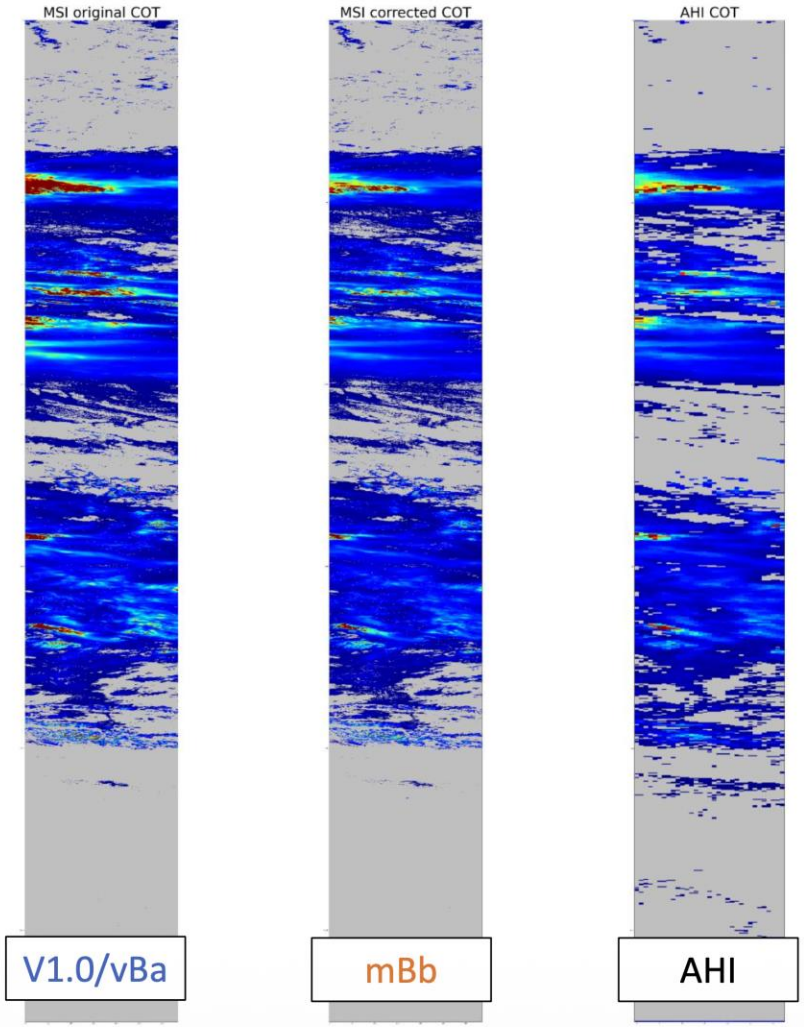
Based on the comparison between MSI_RGR(vBa) & AHI

- Coef01(band1) = 0.924
- Coef03(band3) = 1 (not added)
- Coef04(band4) = 1 (not added)

Case of 06399E (2025/07/14)

ECA_J_MSI_CLP_2AS_20250714T0528_20250714T0539_06399E_vBa.h5





- Compared to v1.0/vBa, the newer L1 data with calibration coefficient applied is now close to Himawari-9/AHI L1.
- Details can be found from Mr. Muto's poster (Annex53, core time 16:30-18:00 on Day4).

Summary

- Two frames with a high concentration of water clouds were carefully selected from the equatorial ocean area on the autumnal equinox day.
- Himawari data was used to perform retrievals of COT and CER, and the MSI water cloud LUT was read to perform radiative transfer calculations, which were then used to calculate vicarious calibration coefficients for MSI band 1 (VIS band) and band 4 (NIR band).
- For L1c (vBa), VNS over-trend was mitigated compared to vAc, but still overestimation found in COT, the calibration coefficient for band 1 was around 0.92-0.94. On the other hand, CER did not show significant overestimation or underestimation, and the calibration coefficient for band 4, was around 0.99-1.04, indicating that nearly no calibration is needed for NIR bands.
- The calibration coefficient has been applied to the newest version (vCa) of MSI_CLP, and the overestimation trend in MSI COT has been significantly mitigated.